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Memorandum

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Original signed on 10/17/03 by
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Date: October 17, 2003

Subject: Surfacing Design Guidelines

In order to reduce confusion and promote consistency in surfacing designs, the Materials Bureau offers these guidelines for the development of surfacing typical sections. While this memo is primarily directed toward design consultants, it provides guidelines that are being used internally.

Plant Mix Surfacing

Plant mix surfacing type is selected mainly on the project quantity. Table 1 is a general guide.

Project Quantity	Plant Mix Type	QA	Lift Thickness	
			Min ~ Max	Recommended
> 10,000 MT	12.5 mm Grade S 19 mm Grade S	Yes, Volumetrics	35 ~ 65 mm 50 ~ 90 mm	40-60 mm 60-75 mm
< 10,000 MT	Grade D, > 50 EASL's Grade B, < 50 EASL's Grade C, Special Cases	No	45 ~ 90 mm	45-70 mm

Table 1

Projects that are large enough to warrant QA specification should be Grade S. Selection of nominal aggregate size (12.5 mm vs. 19 mm) should be based on design thickness. Structurally, the two sizes are considered equivalent. The 12.5 mm Grade S will probably have a higher binder content then the 19 mm. There are separate bid items for the 12.5 mm and the 19 mm. Please be carefull to use the proper bid item.

ESAL's (Daily)	Plant Mix Thickness
> 300	120 mm – 150 mm
200 – 300	100 mm – 120 mm
< 200	90 mm
Other Situations	**Plant Mix Thickness**
Urban Curb & Gutter	120 mm – 150 mm

Table 2

The selection of plant mix type on smaller projects should be made based on traffic conditions (EASL's) and available materials types. A new Special Provision has been developed for non-QA, Grade D, commercial plant mix.

The recommended Plant Mix thickness for new construction is given in Table 2.

PG Binders

MDT uses LTPPBind software with the LTPP high- and low-temperature models for selecting the basic binder grade. The high-temperature reliability target should be 90%. Low-temperature reliability targets are more difficult to set. Overlays on cracked pavement will probably exhibit some reflective cracking, especially on thermal cracks. Generally the low-temperature reliability should not be less then 50%.

The basic binder grade, selected using LTPPBind, is adjusted for traffic volume and load rate according to Table 3, taken from the AASHTO Superpave Volumetric Mix Design specification, to determine the adjusted binder grade. These adjustments effect the high-temperature grade only.

Design ESALs,[b]		Adjustment to the High-Temperature Grade of the Binder[a]		
		Traffic Load Rate		
Daily	Million	Standing[c]	Slow[d]	Standard[e]
41	< 0.3	[f]	—	—
41 to < 410	0.3 to < 3	2	1	—
410 to < 1370	3 to < 10	2	1	—
1370 to < 4100	10 to < 30	2	1	[f]
= 4100	= 30	2	1	1

Table 3

[a] Increase the high-temperature grade by the number of grade equivalents indicated (one grade is equivalent to 6°C).

[b] The anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years.

c Standing Traffic—where the average traffic speed is less than 20 km/h.

d Slow Traffic—where the average traffic speed ranges from 20 to 70 km/h.

e Standard Traffic—where the average traffic speed is greater than 70 km/h.

[f] Consideration should be given to increasing the high-temperature grade by one grade equivalent.

The adjusted binder grade should be reviewed for other considerations including the desire for polymer modification and practicality of the selected binder. Often we will want to insure we are specifying a polymer modified binder. As a general guide, if the range between the high and low temperature grade is more then 90, polymer modification will be necessary to meet specification. For example, the range for a PG 64-28 is 64 + 28 = 92. This will be polymer modified.

Polymer modified binder is desirable for most projects. If the adjusted binder grade is a grade that may not be polymer modified, consideration should be given to bumping to a polymer modified grade such as PG 64-28.

Some areas Montana have a large temperature range that could result in impractical binder grades. One measure of practicality is the range between the high and low temperature grade. When this number exceeds 98, the binder is probably impractical and should be reviewed. For example, a PG 70-28 has a range of 70 + 28 = 98. This binder is at the limit of practicality.

When the adjusted binder grade is considered impractical, the selection should be reviewed. Special attention should be given to any traffic based grade adjustments and the low temperature reliability.

MDT typically uses the PG binder grades shown in Table 4. The relative cost information is approximate and should be used as a general trend only.

Binder Grade	Approximate Relative Cost
PG 70-28	1.1
PG 64-34	1.2
PG 64-28	1
PG 64-22	.75
PG 58-28	.75

Table 4

Reclaimed Asphalt Pavement (RAP)

Our current specification for a RAP plant mix is a Grade D mix with the reclaimed material added. This is a QA specification with incentives calculated on cold feed gradations. This specification may be used on current projects.

We are moving toward Grade S for all large projects. Although we see no problem including RAP in the Grade S mix design, we are concerned about how we include these mixes into the QA system. The RAP introduces a variable into the mix volumetrics that is difficult for the contractor to control. We are looking for a trial project to do under a Grade S, RAP specification to help determine reasonable ranges and QA specifications.

The AASHTO Superpave binder selection guidelines are given in Table 5.

Recommended Virgin Asphalt Binder Grade	RAP Percentage
No change in binder selection	<15
Select virgin binder one grade softer than normal (e.g., select a PG 58-28 if a PG 64-22 would normally be used).	15–25
Follow recommendations from blending charts	>25

Table 5

We have not followed this guide. Typically we specify a PG 58-28 binder in RAP mixes. RAP mixes have typically performed well in Hamburg Wheel Tracker testing. Low temperature performance is unknown. Our normal use has been to include the RAP in the lower lifts and use 100% new material in the top lift.

RAP mixes should be selected on a case by case basis. The amount of RAP to include in the mix and the binder selection should be evaluated for each project. For high RAP percentages, developing blending charts during design should be considered.

Aggregate Base Coarse

All aggregate base coarse must meet the requirements outlined in the MDT Standard Specifications, Supplemental Specifications, or Standard Special Provisions. There is a new specification for Crushed Aggregate Course that allows the contractor to choose between Crushed Base Course Grade 5A and Grade 6A and allows the contractor to choose to use a crushed top surfacing. This is the preferred specification for base course material.

MDT typically specifies no less then 200 mm of Crushed Aggregate Course. That depth includes any Crushed Top Surfacing that may also be placed.

Uncrushed aggregate is not acceptable for base coarse.

Cement Treated Base

MDT often uses Cement Treated Base in areas without economical access to gravel. Our minimum thickness for CTB is 200mm.

Subgrade Evaluation

MDT utilizes R-Value and Resilient Modulus based subgrade evaluation methods. It is up to the designer to determine the most appropriate method of evaluation. MDT can provide deflection basin data from a Falling Weight Deflectometer for most projects if the designer wants to backcalculate the data and use the resulting resilient modulus. Please contact John Amestoy for deflection data.

California Bearing Ratio (CBR) is also an acceptable method of subgrade evaluation. However, CBR testing is not normally performed at MDT.

If CBR or resilient modulus is utilized for design, MDT requests that the designer provide a correlated R-Value for construction purposes.

R-Value During Construction

The R-Value is often used for borrow source approval or subgrade design checks during construction. When used as a Borrow Source Approval, a specification similar to MDT Standard Special A43, Borrow Source Approval–Resistance Value should be used. The specification should use an 85th percentile R-Value statistical method for pit approval and then acceptance on the roadway by soil classification. The specification generally should not require both an R-Value and a soil class. The soil class of the material should be determined during R-Value testing and that classification used for acceptance.

R-Value testing is also used as a final design check during construction. The procedure is described in the Materials Manual. This testing is not a construction contract requirement. It is the final check of the assumed parameters during design.

Low Volume Design

The 1993 AASHTO Guide for the Design of Pavement Structures has a good section on low volume design. MDT's experience shows that this works well for < 100 ESAL's in areas with poor soils.

Portland Cement Concrete Pavement

Minimum Thickness - 230mm
Dowel Bars are recommended

Alternate Typical Sections

MDT encourages alternate typical section design and economic analysis.

Typical Sections Utilizing Geosynthetics

MDT normally specifies geosynthetics only for known or suspected problem areas on a project. Geosynthetics are typically not used full length of a project.

MDT is in the research implementation stage for research project FHWA/MT-01-002/99160-1A Mechanistic-Empirical Modeling and Design Model Development of Geosynthetic Reinforced Flexible Pavements. The research performed by Dr. Steven W. Perkins, suggests that under certain conditions aggregate base course sections may be reduced through the appropriate placement of geosynthetics.

MDT encourages consideration of this design process as an alternate typical section design. The report and associated design spreadsheet may be found at: http://www.mdt.state.mt.us/research/projects/grfp.html.

Since this is a research implementation, early coordination is needed for any project where this design method may be recommended. Inclusion in the project will probably require designating the project as an experimental project and including control sections and an experimental monitoring program.

Closing

We encourage anyone with questions relating to design parameters or alternate typical sections to contact the Surfacing Design Unit.

Surfacing Design

Jim Tompkins	444-6295
Ed Shea	444-7650

Nondestructive Testing Deflection Data
John Amestoy 444-7651

The information given is fairly general. It is based on both successes and failures on construction projects throughout the State over a long time. We want engineered solutions to a project's problems. Situations that don't fit these guidelines may be encountered. We would like early coordination on any designs that vary from these guides.

This information is intended to supplement and update the 1991 Pavement Design Manual. Please distribute this memo to all consultants involved in surfacing design.

KMB: SURFACING_GUIDE_10-2003.DOC

copies: File

E-Mail to: MDT Engineering Bureau Chiefs
MDT Engineering Phase Review